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THE MEDICAL ENTOMOLOGY OF SALONICA

BY

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SURGEON-GENERAL WHITEHEAD AND GENTLEMEN :—

At the outset I would ask you kindly to disabuse your minds of any idea that I claim to be an expert entomologist. Indeed, I am only sorry that Mr. Austen of the British Museum, now in Egypt, is not here to speak to you in my place. In his absence, however, I must do my best, and I can at least claim to have suffered many things from many insects. To use a time-honoured sporting phrase, my claret has been tapped by seroot flies on the Upper Nile, by beautiful green and vicious *Lepidoselaga* on the Orinoco, Magdalena and Atrato Rivers, and by Mosquitoes, Ceratopogons, Simulidæ, Stomoxidæ, *Phlebotomus* and a host of other flies in several parts of the old and the new world. Hence, I feel I can address you with some confidence. Further, I intend, this afternoon, to confine myself more or less strictly to Medical Entomology, and as I have myself suffered from malaria, phlebotomus fever and paratyphoid, the last-named almost certainly the result of fly infection, I can claim to have some practical experience of my subject.

It seems to me that the most simple way of approaching the medical entomology of Salonica is to divide its insect pests into the winged and the wingless forms. Some may think it is rather presumptuous on my part to attempt to deal with the insect fauna of a district to which I was a stranger three weeks ago, but, after all, there is no need to enter into minute details, and, so far as I have seen, the pernicious insects of Salonica do not greatly differ from those of other parts of Southern Europe with which I am to some extent familiar. Moreover, I am



Fig. 1—*Musca domestica*
The common house fly

indebted to Mr. Anderson of the 20th Stationary Hospital both for information and some specimens, while I have been doing a little collecting as occasion offered. At least, like yourselves, I am only too well acquainted with the first of the winged insects I will bring to your notice, namely, the House Fly, *Musca domestica* (Fig. 1).

Our Canadian friends call this fly, with good reason, the Typhoid Fly, but it might just as well be termed the Paratyphoid Fly, or the Dysentery Fly, or the Cholera Fly, or the Helminth Fly, or possibly even the P.U.O. Fly, though the evidence before us at

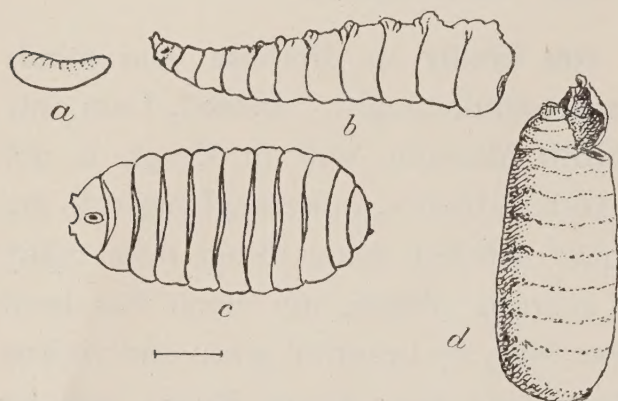


Fig. 2—*Musca domestica*

a. egg; b. larva; c. pupa; d. empty puparium

present does not point in this direction. Now the house fly, though useful enough as a scavenger, speedily becomes a nuisance and a danger when it invades the habitations or camps of man. It is one of the most fecund of animals. Just think what a single female can accomplish! She lays 120 eggs in one batch, and during the year she may lay four

such batches. Taking only one batch, let us say that half the flies that hatch out, i.e. 60, are females. Provided the progeny of these 60 females and that of succeeding generations all reach maturity, a state of things which, let us thank God, never occurs, the original mother fly would in six months become the ancestress of no less than 5,598,720,000,000 adult flies. Consider what this means, and, if your arithmetical knowledge suffices, make the calculation for all four batches. You may be able to do so, but no human mind can adequately picture the result. This is one reason why delay in fly preventive measures is fatal. It is not, however, a reason for sitting with folded hands and saying that fly prevention is a hopeless task. Fly *extermination* is hopeless. Fly *prevention* within certain limits is not only possible but essential.

Now all these flies come from eggs. Where are these eggs laid? In filth of some sort or other, and usually in local filth. By the flies of their own breeding ye shall know the dirty and the careless unit. In this country there are two main sources of flies—the one, Human Excrement, and the other, Horse Manure. I have not been here long enough to say which is the more common at present, but, as the summer heat increases, I believe the former will infallibly prove to be the chief source of flies. In any case, it is, of course, the more dangerous. Apart from any question of faulty military sanitation, we must remember that just as the wind bloweth

where it listeth so does the itinerant native ease himself where and when it pleases him. If you have any doubts as regards this statement, go and walk about the marshes bordering the Monastir Road! You all know that the fly egg becomes a larva, that the larva changes to a pupa, and that from the pupa the adult emerges; but I wonder how many are familiar with the white, sticky, shiny, cigar-shaped eggs, are acquainted with the cream-coloured footless maggots, know the brown pupal cases or puparia, and have seen the young adults with unexpanded wings emerging from their breeding-places and looking, at a short distance, for all the world like little spiders (Figs. 2 and 3). It is the duty of every medical officer to acquaint himself with the appearances of every stage in the life-history of his deadly enemy, the fly. I have said I am not going much into entomological detail to-day, but it is necessary to remember that, unlike the adult fly, the larva loves the darkness rather than the light, although its work is beneficial; and it is also needful to recall the fact that under the most favourable conditions of temperature and food supply, the life-cycle from the egg to the adult takes about eight or ten days for its accomplishment. While this is true as a general rule, I must tell you that some experiments carried out last summer in Khartoum

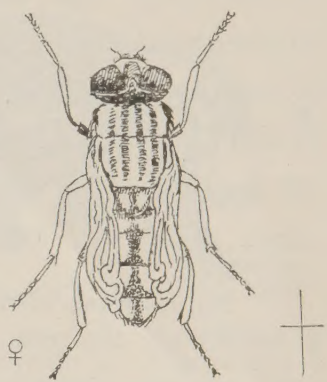


Fig. 3—*Musca domestica*

Just emerged from the pupal case. Note the wings, as yet unexpanded, folded and crumpled on the back of the insect

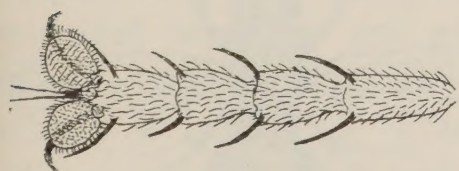


Fig. 4—*Musca domestica*

Foot, showing hairs on which bacteria, etc., lodge

showed that the whole period of development might be as short as five days. Taking all kinds of conditions into consideration, we may say that the period varies from five days to as much as eight weeks. As soon as fly larvæ have fed and become full-grown, they migrate from their source of food, and, wherever possible, work their way down into the subjacent and surrounding earth where they proceed to pupate. In loose sand they may reach astonishing depths—even six feet and more having been recorded. The pupal stage itself lasts, as a rule, from three to five days, and then the fly escapes from the pupal case by pushing off the anterior end of the latter by means of its inflated frontal sack or ptilinum, a vestige of which remains on the head of the adult fly.

As house flies breed in filth, a certain proportion of them actually begin life infected, and a consideration of the adult insect shows how admirably adapted it is for the conveyance of disease germs. I take it you are all familiar with the external anatomy of

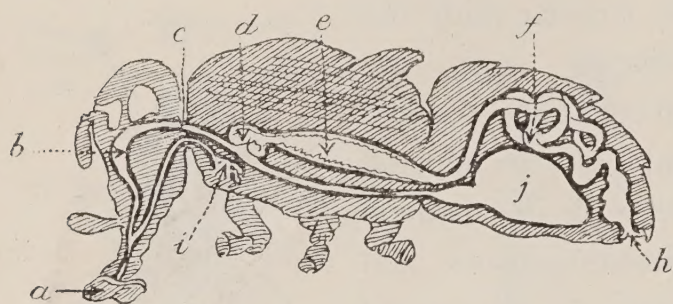


Fig. 5—*Musca domestica*. Internal anatomy

a. tongue ; b. sucking pharynx ; c. oesophagus ;
d. proventriculus ; e. chyle stomach ; f. intestine ; h. anus ;
i. salivary glands ; j. crop.

the fly can and does carry pathogenic bacteria which it may transfer to foodstuffs with disastrous effects. Of more importance to us at the present moment is its internal anatomy, for much of the damage which a fly does is due to its habit of spending the live-long day vomiting and defecating. This is not a pleasant thought, but it has to be faced.

Well, the fly has a mouth, a cylindrical tube occupying the first half of the proboscis and passing into the sucking organ or pharynx. From the latter the oesophagus extends backwards, bifurcates and communicates with the crop and with the proventriculus. The latter runs to the chyle stomach from which springs the intestine, passing on into the rectum which ends in the anus (Fig. 5). Now, before feeding, the fly must imbibe liquid, and its diet, like that of a typhoid case, is fluid. At first this fluid passes into the crop, and when this is distended or, if the fly is disturbed, before distension has occurred, it finds its way into the proventriculus which acts as a kind of mixing tank to prepare an emulsion suitable to the fly's stomach. After a meal, regurgitation takes place, and the fly spots with which you are familiar are due in part to matter excreted from the anus and in part to vomit. So

the house fly ; with its sucking proboscis, its hairy body, its hairier legs with their claws and pulvilli or membranous pads which are covered with secreting hairs so that the fly can walk upside down on the most polished of surfaces (Fig. 4). You know also that on its body, wings, legs and feet

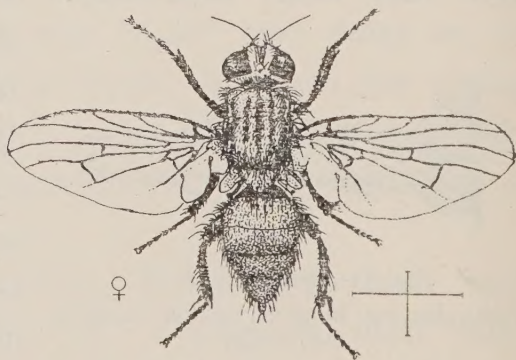


Fig. 6—*Fannia canicularis*
The latrine fly

much for the fly's internal arrangements. I want to-day specially to direct your attention to what happens in the case of amoebic dysentery as recently worked out by Lieut.-Colonel Wenyon and Captain O'Connor, R.A.M.C., at the Orwa-el-Waska Hospital in Alexandria, not only for *Musca domestica*, but for *Fannia canicularis*, the little house fly or latrine fly, and for both Green-bottles and Blue-bottles. As you know, *Entamæba histolytica* produces in the human intestine cysts with transparent capsules and four nuclei which are passed in large numbers in the fæces of cases of untreated or improperly treated dysentery patients or convalescents. It has now been demonstrated for the first time what really happens when flies take up these cysts. Within 20 or 30 minutes of feeding on human fæces, and in some cases even five minutes after such a feed, flies begin to deposit droplets of liquid fæces, and in these the unaltered and living cysts can be seen if the fæces on which the fly has been feeding contained them in the first instance. Within a few hours thousands of cysts may pass through a single fly, and if the fly finds its way to food, as it so commonly does, they are deposited on the latter, and the way made easy for a dysenteric attack.

So far there is no evidence that flies regurgitate the cysts, and it is unlikely that they are carried on the outside of the fly, for flies clean themselves after feeding on fæces and do not move far until they have got rid of most of the foul material adhering to them. What remains soon dries and, as a result, the cysts die. As regards bacillary dysentery, let us only note that dysentery bacilli have been recovered from flies two or three days after their absorption by these insects. The rôle of the fly in spreading typhoid bacilli and the vibrios of cholera is, I take it, sufficiently well known to you. Cholera vibrios have been found in the fæces of flies for 24 to 36 hours after infection.

The whole question of fly prevention is much too big a subject for me to consider fully to-day, but remember that 500 flies can breed out from a single deposit of human fæces, and that 4000 of these pests can emerge from 1/6th of a cubic foot of sewage trench ground. Remember further that, even in a temperate climate, horse manure not over 24 hours old produces, if left alone during the warm months, an average of 10,000 to 12,000 flies per cubic metre, and thus one horse may, in a manner, during the summer become the parent of from 40,000 to 50,000 flies a month. The temperature of Salonica is

just about right for this kind of performance at present, so, Gentlemen, let us be up and doing, for once the vicious circle is established the difficulties multiply enormously.

To save time, I exhibit photographs showing methods of protecting latrines, etc., from flies, but all I would say about the matter is that when you cannot deal with all the breeding-places, as in a locality like the Salonica area with its deposits of human ordure here, there and everywhere, you must deal with adult flies. You all know about

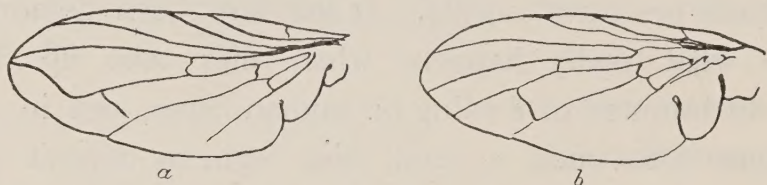


Fig. 7—The wings of *Musca domestica* and *Fannia canicularis* contrasted

- a. Wing of *M. domestica*. Note upturning of the distal portion of 4th longitudinal vein towards the 3rd vein.
- b. Wing of *F. canicularis*. 4th longitudinal vein not upturned

sodium arsenite, and formalin, and solution "C," and flaming, and the use of mosquito nets as drag nets in mess huts and tents, and the use of fish-netting to keep flies out of tents and buildings; and fumigants and tanglefoot, and small traps used, as I think, quite erroneously indoors; but I would ask you to note the use of large and simple traps placed outside cook-houses and messes, which trap flies in thousands, and certainly serve to lessen the fly population and to slay infected Muscidae. These traps, if properly operated, have been proved to free such places from flies to a very considerable extent. Flies do not, as a rule, travel far, but they can easily cover half-a-mile, and it is known that they can traverse a mile with a favouring breeze.

So much for the house fly. After birth it does not grow, and hence when you see a so-called small fly it is either a house fly which has been stunted in its growth during its larval stage, or it is a different species, *F. canicularis* (Fig. 6) or *F. scalaris*, the latrine fly, which not only does all that the house fly does, but is known to cause a form of intestinal and even of urethral myiasis. The adult is very like the house fly, but is smaller and more slender, and can readily be distinguished by the fact that the fourth longitudinal vein of the wing does not bend upwards towards the third vein, but runs straight to the edge of the wing (Fig. 7). The larva of *Fannia*, whether *canicularis* or *scalaris*, is quite different from that of the house fly, for it possesses a

number of spinous processes which give it a curious and almost feathered aspect (Fig. 8). *Fannia* does not come much into houses, but it frequents tents and marquees.

In the earlier part of last summer it was much the more common fly in Mudros and apparently on the Gallipoli Peninsula, but, so far as I have seen, it is not so much in evidence about Salonica. It is



Fig. 8—*Fannia canicularis*
Larva

to be slain wherever and whenever found. Many of you must have cast a disgusted eye at deposits of human fæces. Have you ever noticed that it was sometimes difficult to see them until it was almost too late by reason of the brilliant green flies clustering upon them and feeding greedily

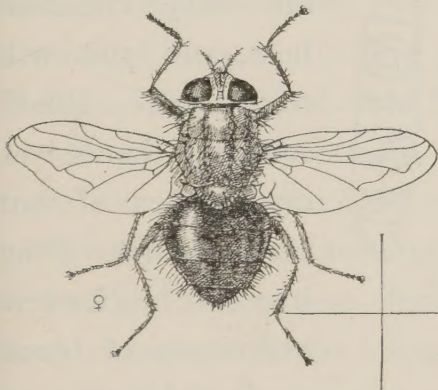


Fig. 10—*Calliphora erythrocephala*
The "Blue-bottle"

upon them? These are species of *Lucilia* of which I show you specimens. *Lucilia caesar* is the commonest species (Fig. 9). It is an excellent scavenger, but unhappily does not confine itself to filth. Therefore, again, our motto must be "Away with it"! The same is true of the familiar blow-flies or blue-bottles, the *Calliphora*, many of them with red heads and all possessing an aggressive buzz (Fig. 10). They do not seem to be quite so common in the Salonica area as the *Lucilia* flies.

Our next fly (for we must hurry on) is much more a veterinary than a medical unit, and yet it possesses some interest, for one species at least is said to carry the virus of epidemic poliomyelitis. I refer to *Stomoxys calcitrans*, the stable fly (Fig. 11). The Stomoxidæ are remarkably like smallish house flies, but each is a blood-sucker, being furnished with a stout piercing proboscis, swollen at the base and capable of drawing a scarlet head at every thrust. Look for these flies on the withers and fetlocks of horses and mules, though not infrequently they bite man, as I can testify.

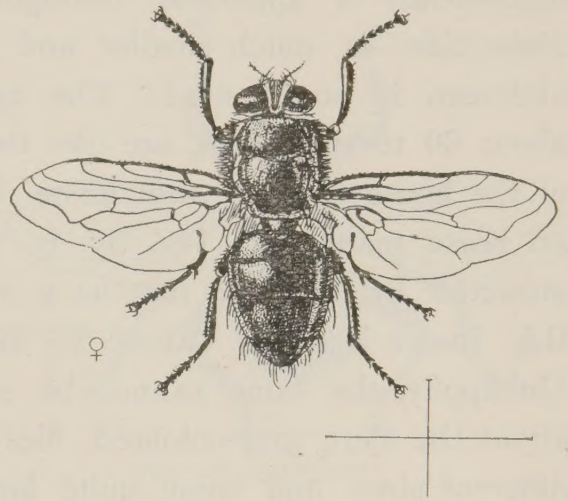


Fig. 9—*Lucilia caesar*
The "Green-bottle"

S. calcitrans has black spots on its abdomen which readily serve to distinguish it from *Musca domestica*. The species I have taken here—really a *Lyperosia* belonging to the same Family as the *Stomoxidae*—is much smaller and its abdomen is not spotted. The eggs, about 60 to the batch, are like those of the house fly, and the larvæ live on horse manure. The fly is not attracted by food, so that as a rule this insect is not a danger to man. Unhappily, the same cannot be said about the alert, grey-coloured flies of different sizes, and some quite large, which feed on decomposing matter and other filth and bear the ominous name of the carcase flies. These are the Sarcophagidæ (Fig. 12), and I removed a small one from a marmalade pot on the Braemar Castle

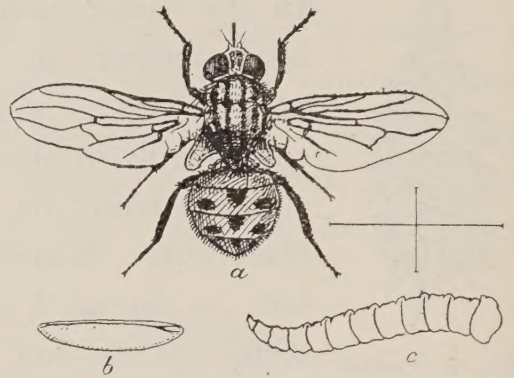


Fig. 11—*Stomoxys calcitrans*
a. imago; b. egg; c. larva

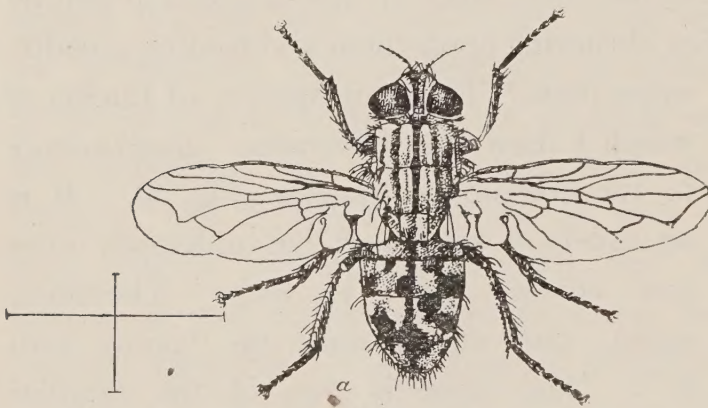


Fig. 12—*Sarcophaga* sp.
a. imago; b. larva

the day I arrived in Salonica. They are very common here, and you will often see them sunning themselves on patches of hot sand or earth. They have checkered abdomens of black and white and reddish heads, and either lay cigar-shaped eggs like those of *Lucilia* and *Calliphora* or extrude living larvæ. The latter are furnished with powerful claws and, as you know, have often been found in wounds during this war. They can tear and consume all animal tissues, including even soft bone, and have been known to burrow deeply and to cause death. Hence, carcase flies are to be dreaded both in the larval and the adult stage.

As we have considered a fly which gives birth to living larvæ, we may as well speak of another which does the same, though the larva turns so quickly into a pupa that the group to which the fly belongs, which includes the dreaded tsetse of Africa, is termed the Pupipara. The representative of this family, which is common in the Salonica area, is a veterinary unit, a *Hippobosca* or tick fly, for it is

much more like a tick than a fly (Fig. 13). You must have seen these insects—dark, flat, ugly, leathery and yellow-marked—on the hides of horses and cattle and often clustering under the tails of these animals, whose blood they suck. One of the species in South Africa is the vector of *Trypanosoma theileri*. They rarely, if ever, bite man, but they have sharp claws and cling closely as a brother to your skin or clothing, giving rise to a sensation of loathing. Quite recently the view has been advanced that the Hippoboscidae of the dog convey *Leishmania tropica*, thus causing Oriental sore. They can easily be caught by hand but are not easily killed. The best way to deal with them is to imitate the tactics of Cromwell in the case of Charles I.

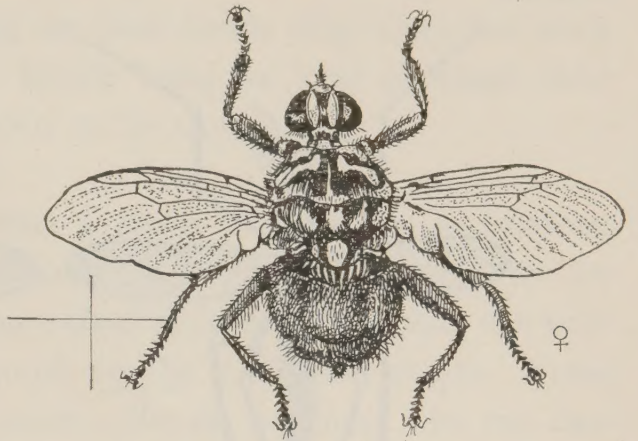


Fig. 13—*Hippobosca*

We will now pass from these larger diptera to more tiny but equally important flies, one family of which is said to have altered the history of Greece, to have accounted for the degeneration of the ancient Hellas. Needless to say, I refer to the mosquitoes.

A great many people, including many medical men, seem to think there are only two kinds of mosquitoes—*Anopheles* and *Culex*. As a matter of fact, thousands of species are known, divided into all kinds of families and genera, most of which bear names which appear to have been chosen as brain exercises or to convert sane men into lunatics. Happily for our purposes we can limit ourselves to the section of the sub-family Culicinae known as the Anophelinae, and to the section called Culicales, which includes the *Culex* and *Stegomyia* groups. Indeed, as regards *Stegomyia* (Fig 14), I doubt if it should be considered at all amongst the mosquitoes of Greece. I only mention it because it is an excellent traveller and may readily find its way to Salonica from Egypt and elsewhere on board ships. I have not yet met with it here, but, during the summer, I should not think the night temperature falls below 20° C., which is that at which this mosquito loses activity and ceases to breed. Hence, for all I know, it may be found occasionally in cisterns or barrels and other domestic water collections during the summer in Salonica. It is, of course, the yellow fever mosquito, and may be the carrier of the unknown organism of that

obscure form of jaundice known as Mediterranean Yellow Fever which is endemic at Smyrna and elsewhere along the eastern Mediterranean littoral.

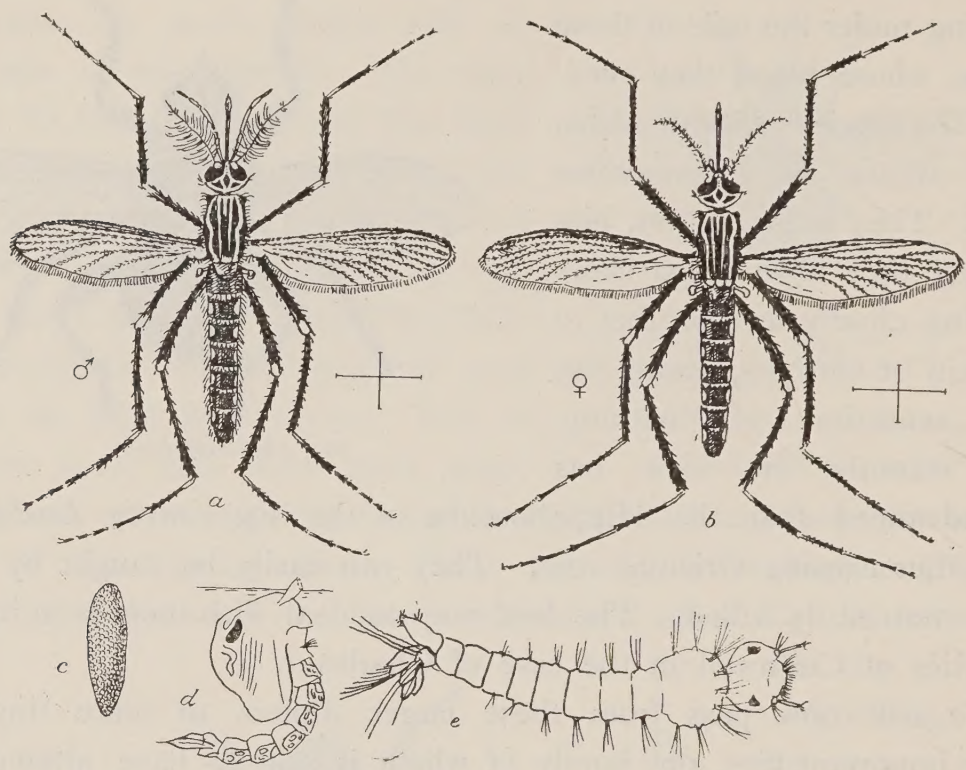


Fig. 14—*Stegomyia fasciata* (*Aedes calopus*)
The "Yellow-Fever Mosquito"
a. male; b. female; c. egg; d. pupa; e. larva

However that may be, there is no doubt about the Anophelines, the three chief Grecian species of which are now breeding out. The adults are very easily distinguished. Two—*Anopheles maculipennis* (Fig. 15), and *A.* or *Pyretophorus superpictus*—have spotted wings. The

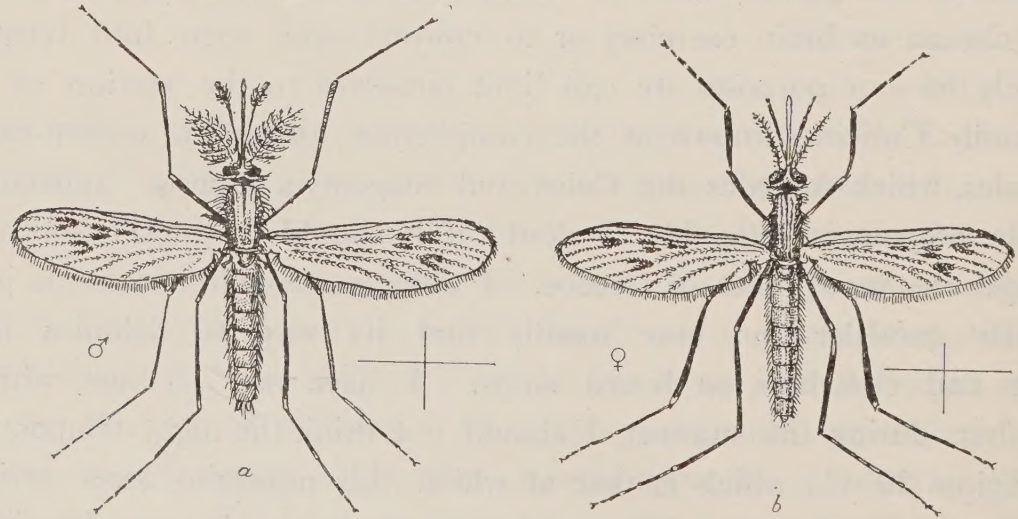


Fig. 15—*Anopheles maculipennis*
a. male; b. female

third, *Anopheles bifurcatus* is clear-winged. The spotted-winged species are easily told, the one from the other, for *A. maculipennis* has the spots,

which consist of clumps of scales, scattered about the wing membrane, while in *A. superpictus* they occur along the anterior margin of the wing or costa (Fig. 16). All three possess the other common Anopheline characteristics, standing on their heads (Fig. 16A), not being hump-backed, and the palpi of the female being as long or longer than the proboscis, not short and clubbed as in *Culex*.

Remember that there exists here a genus of Culicales mosquitoes, which possesses spotted wings and hence is apt to be mistaken for *Anopheles*. This is *Theobaldia*, so called after Mr. Theobald, the well-known author of the great monograph on the Culicidæ of the World in—let it be spoken with bated breath—five fat volumes! In the case of all Culicidæ, the male can be distinguished at a glance from the female, the antennæ of the former being plumose or bushy, those of the latter pilose.

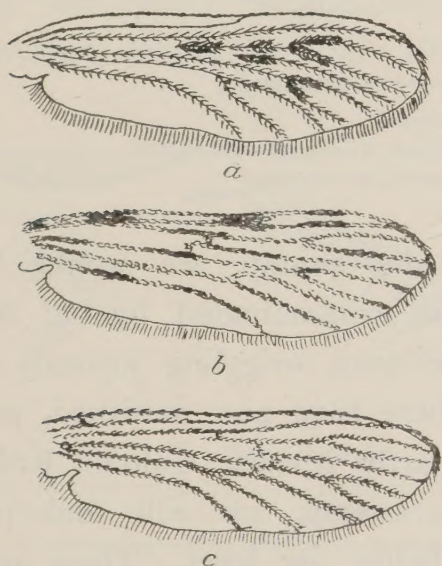


Fig. 16—The wings of three important species of *Anopheles*

- a. *A. maculipennis*
- b. *A. superpictus*
- c. *A. bifurcatus*

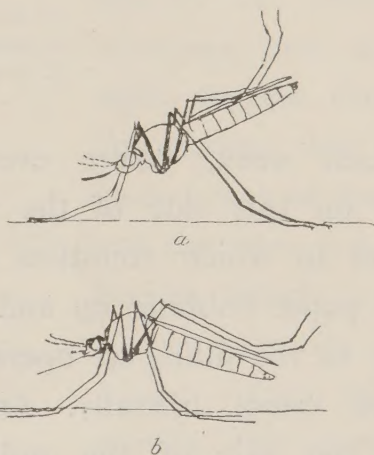


Fig. 16A—*Anopheles* (a) and *Culex* (b)

In resting position. Note angles assumed by the bodies of the insects, relative to the surface on which they are resting.

The malaria map, kindly furnished by Captain Galwey, shows where we may expect to find the Anophelines, for, be it noted that all three species are known malarial carriers. Albeit the proof has been better established in the case of *A. maculipennis* and *A. superpictus* than in that of *A. bifurcatus*. The two former find a favourite breeding-ground in the swampy pools bordering the Monastir Road, while I have taken *A. maculipennis* and *A. bifurcatus* in dug-outs not far from Lake Langaza. I also secured a fine male *A. maculipennis* in my tent at the 4th Canadian General Hospital. Do not mistake

harmless midges or Chironomidæ for mosquitoes. In the former the long narrow abdomen is nearly always turned up at the end (Fig. 17).

I ask you to accompany me in imagination to the swamp area. It is a less expensive method, as regards boots and perspiration, than actually going there.

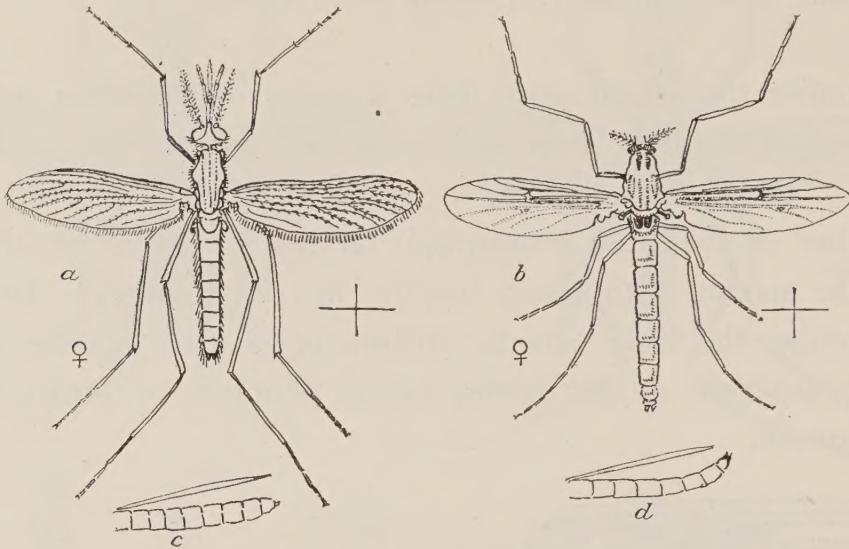


Fig. 17—A *Mosquito* and *Chironomus* contrasted

- a. *Mosquito*; b. *Chironomus*;
- c. posterior end of abdomen of *Mosquito*—straight;
- d. posterior end of *Chironomus*—upturned

Last week, before ever reaching the swamp, we would have found on this side of the railway, pools contaminated by old horse manure in which countless *Culex* larvæ were wriggling joyously and *Culex* pupæ bobbing up and down. These have now vanished, partly owing to the filling-up operations and partly because Colonel Roberts applied cresol liberally. Once in the swamp, we will find pools along the side of the mill-lade and below its level. These pools, often surrounded by reeds and rushes, are full of several species of water weed. They are also full of frogs, snails, leeches and all kinds of aquatic life. Here a lucky dip will discover the large, green larvæ or pupæ of *A. maculipennis*, or the small dark, fairly active, white-collared darters of *A. superpictus*. We may also light upon *Culex* larvæ of different species, but are not very likely to find eggs.

The fusiform eggs of *Culex* are laid in little concave rafts, the winged eggs of *Anopheles* separately or in star-shaped clusters. A female *Culex* may lay as many as 400; a female *Anopheles* is doing her duty if she deposits 40 to 100. In two or three days larvæ hatch out from the eggs.

Culicine larvæ are more active than Anophelines, and, owing to the presence of respiratory syphons or breathing tubes, hang head downwards when at the surface, save when swinging round their heavy jaws and heads to engulf some savoury, floating morsel. Anopheline larvæ lie parallel to the surface and look like little bits of floating sticks. They also possess a different shape, the thorax not being so square and marked off from the abdomen as in the case of *Culex* larvæ.

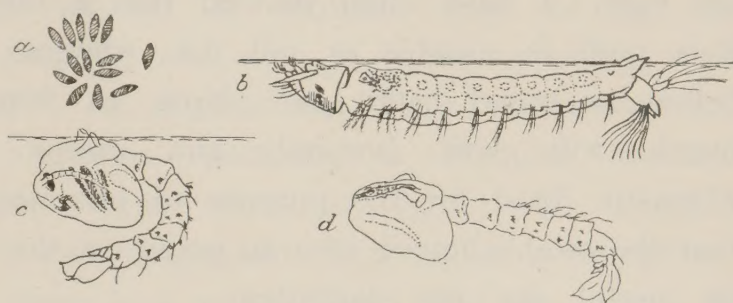


Fig. 18—*Anopheles*

a. eggs; b. larva (note resting position, body *parallel* to surface of water); c. pupa; d. empty puparium from which mosquito has emerged

The latter are typical wrigglers, the former tend to dart backwards along the surface of the water and jerk rather than wriggle when submerged (Figs. 18 and 19). In these swamps the larvæ of a

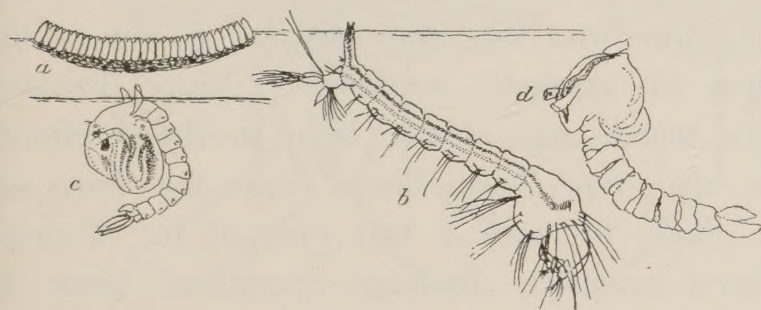


Fig. 19—*Culex*

a. egg raft (side view); b. larva (note resting position, body hanging at an angle from surface); c. pupa; d. empty puparium from which mosquito has emerged

species of *Dixa* are common, and at first sight suggest those of *Anopheles*, but they have a way of looping, not the loop, but their bodies, which is quite characteristic (Fig. 19A). After several moults the mosquito

larvæ become pupæ—in a week or ten days as a rule, but much depends upon temperature and food conditions. The pupæ, or nymphs, are interesting and beautiful objects, what with their bobbing movements, lashing paddles, respiratory trumpets and the eyes of the future gnat showing black through the chitin. After two or three days a split appears along the upper part of the pupal case and the curled-up mosquito uncurls itself, slowly emerges and, unless entangled at this wonderful and critical moment, stretches its wings and flies away. Think what its feelings must be when it finds itself in a bottle closed by a piece of netting and without any opportunity for blood-sucking. I need hardly say that I refer to a female. I do so because only the female sucks blood. She is off

on the blood quest at once, whether she be *Culex* or *Anopheline*. It is apparently an acquired habit, though she seems to require the blood-food for the proper development of her eggs. After fertilisation she proceeds to the nearest suitable water collection to lay her eggs. I have often noticed that a mosquito knows by instinct if a pool is suitable or not, i.e., whether it will dry up or not before her brood hatch out. Now, as female mosquitoes from the marsh will visit hospitals and camps on the north side of Monastir Road for the purpose of imbibing blood, it seems to me that the establishment of trap pools on this side of the railway may be useful, for the egg-laden *Anopheline* will visit them on her return voyage, and, finding them most attractive, will lay her eggs in them, not knowing



Fig. 19A—*Larva of Dixa*

that inspectors are on the prowl. You will see that the mosquitoes have enemies. Foremost among these I will place Major Johnson, who has directed the drainage work of the fifteen hundred acres of swamp; Captain Shingleton who has ably carried it out, and Captain Litt who has lent his energetic assistance. Major Bissett, an officer of that service which has always been in the forefront of tropical hygiene, has also now been drawn into the fray, so that the mosquitoes are likely to have a bad time of it. I may say I have not seen such extensive drainage operations since I witnessed the colossal work of the Americans in the Panama

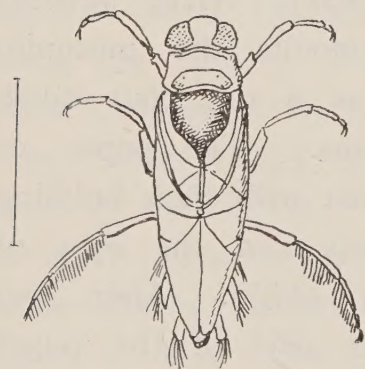


Fig. 20—*Notonecta*
The "Water-boatman"

Canal zone. The only other enemy I will mention is the *Notonecta*, or water-boatman, which swims on his back and looks rather like a submerged monoplane (Fig. 20). Several species abound here, and it is interesting that, where they occur in pools free from weed, mosquito larvæ do not seem to be present. It may be possible to utilise these carnivorous insects which grip larvæ as a terrier grips a rat and then engulf them slowly, tail first—a

pleasant and a joyous sight! However, it must be remembered that they can wing their way out of the pools, and hence they might hie them home if the new quarters were not to their liking. We need not say much about the species of *Culex* found here.

There is one, in all probability *Culex pipiens*, which is very near *Culex fatigans* (Fig. 21), the vector of the unknown parasite of dengue fever which is known to occur along the Grecian coast. I have not had time to work out those I have captured. Here we are just north of the 40th parallel of latitude, said to be the northerly limit of *C. fatigans*, but it is quite possible that it occurs in this locality. As regards the flight of mosquitoes, we knew little till an ingenious American at Panama invented an instrument for catching them when in flight. It consisted of plates of glass smeared with tanglefoot which makes a transparent surface. He found that there is a return flight, that the insects fly much higher and swifter in the morning than they do at night, and that usually only adult females are in flight. As regards range, few

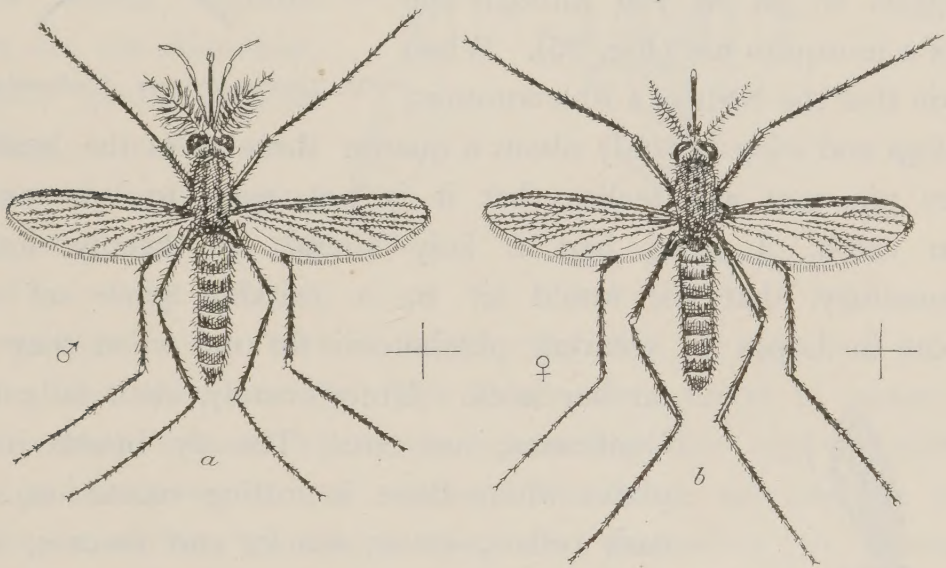


Fig. 21—*Culex fatigans*
a. male; b. female

Anophelines travel more than half-a-mile to a mile, but a favouring breeze may waft them considerable distances, especially if there is shelter on the way. I may perhaps here recall the fact that the irritation following a mosquito bite is due to the entrance into the little wound of a fungus derived from the oesophageal diverticula. It is not due to the secretion from the salivary glands which so often harbour the sporozoites of the malarial plasmodium. One might speak all day about anophelines and malaria, but everyone here naturally knows all about micro- and macrogametocytes, zygotes, oökinets and sporocysts, so, after a word about the small and vicious flies known as the Ceratopogons, we must hasten on to the Phlebotomus fly which is likely to be of special interest to you,

and take a special interest in you during the Salonican summer. I mention the *Ceratopogons* because I found a lot of them caught in spiders' webs outside the boat-patrol dug-out at Aivasil. They are blood-sucking Chironomids, and, for their size, are amongst the most vicious insects alive. The so-called *Culicoides* are the worst, and they have blotchy wings devoid of scales (Fig. 22). They bite during the day and in the evening, but happily do not carry any disease. The same cannot be said of *Phlebotomus papatasi*, often, but erroneously, called a sand-fly, one of the Psychodidæ, or owl midges, a minute fly, hairy as Esau, and with prodigiously long legs which it will trail behind it as it struggles to get at you through the mesh of a mosquito net (Fig. 23). When I tell you that the body of a *Phlebotomus*,

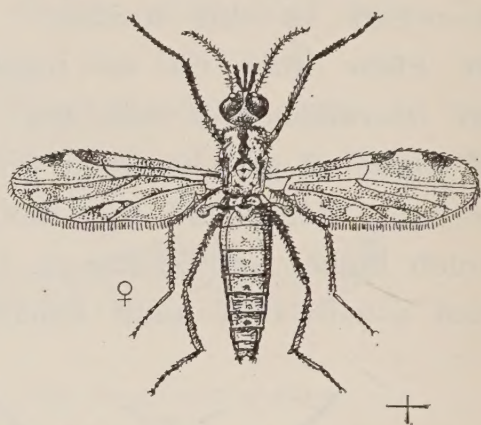


Fig. 22—*Ceratopogon* (*Culicoides kiefferi*)

minus legs and wings, is only about a quarter the size of the head of an ordinary pin, you will realise that it is not easy to see and still less to catch. I once had a lady friend, so keenly interested in entomology, that she would sit in a suitable place of a late afternoon in hopes of securing phlebotomi for me when they settled

on her neck. Unfortunately, such lady friends, Gentlemen, are rare! The fly breeds in damp places where there is rotting vegetation, such as dark cellars, caves, cracks and fissures, in soil, under damp stone walls, in tunnels, the earthen parapets of trenches, etc. The tiny egg hatches into a minute caterpillar-like larva, with a spinous body and several long hairs at its posterior end. After pupation the imago emerges. In most species only the female sucks blood. Towards evening they sally forth and make their victims' lives a burden, attacking especially the wrists and

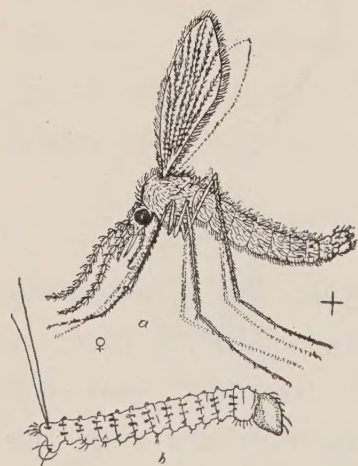


Fig. 23—*Phlebotomus papatasi*
a. imago; b. larva.

ankles. During the day they frequent their breeding-places, the beds of streams, holes in trees, etc. It has recently been shown that they can easily be transported in timber and other cargo by sea-going vessels, a matter of some importance in these days of hospital huts, cooking sheds, etc. They are attracted by lamps and candles, but dislike the sunlight. A single fly is sufficient to infect a man with the unknown

virus of sand-fly fever, three days' fever, or, as it used to be called, "dog disease," from the congested look of the conjunctivæ. It is beyond the scope of this paper to deal with phlebotomus fever and its treatment, but one may mention that for the attacks of Papatasii flies, as for those of mosquitoes, cassia oil is useful, or, if this cannot be got, a mixture of eucalyptus oil, oil of anise and oil of turpentine in lanoline. A lump of camphor as a bedfellow also acts as a repellent. Another family of flies which requires mention are the Simulidæ, or buffalo gnats, or true sand flies ; small dark hump-backed flies, ranging in size from that of the head of a large pin to

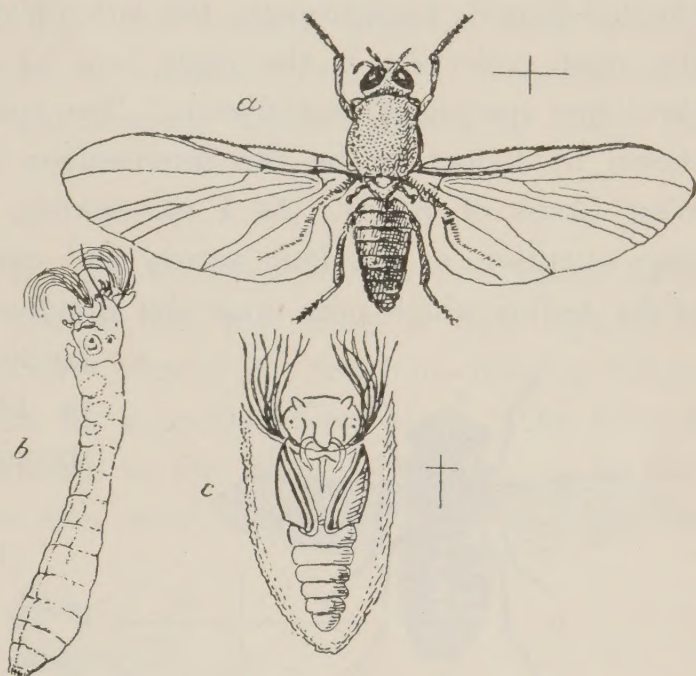


Fig. 24—*Simulium*

a. imago; b. larva; c. pupa

about one-eighth of an inch in length (Fig. 24). I have not yet found any here, but there can be little doubt they breed in some of the rocky mountain streams where the female lays her eggs in gelatinous masses on water weeds and stones. The larvæ are peculiar in that they have a sucker by which they fix themselves to stones and weeds. The pupæ live in a kind of cocoon. These sand flies are terrible biters. One of them was once described to me by an irate friend as being evidently the misbegotten progeny of a female *Culex* and a deformed house fly, but he had suffered very severely and doubtless saw the fly with distorted vision. When I tell you that one of the species is called *Simulium damnosum* you will admit that he had some justification for casting doubts on the fly's ancestry. Sambon attributes pellagra to the bites of these insects, but the evidence is all against this hypothesis.

As they are very rarely disease-carriers in man, I will make but brief mention of the large, stoutly-built Brachycera found in this part of the world, the Tabanids, the Hæmatopotas or Clegs,

and the Chrysopidæ flies which plague the lives of horses and cattle, and not infrequently thrust their needle-like probosces through the human cutis (Fig. 25). They are very common on the Vardar, but are also found nearer home. You will see two species of Tabanids and a clouded-winged Hæmatopota, the latter given me by Mr. Anderson, in the small collection in the cigar box. I am also able to show you three fine specimens of Chrysops. Two species of this genus have been shown by Leiper to be the intermediate host of *Filaria loa* on the West Coast of Africa. As I am dealing with them, I would direct your attention to the long narrow and curious looking robber fly, one of the Asilids which prey upon the Brachycera and other insects. Very

rarely an Asilid has been known to bite men. There are two specimens in the collection.

Turning now to the wingless pests, pride of place must be given to lice, the Scots Greys, as they were (I cannot help thinking) somewhat impertinently called during the South African War (Fig. 26). We need not trouble about the crab louse, which is comparatively rare, but the head- and body-lice deserve close attention, for, as you know, they are the carriers of the spirochæte of relapsing fever, and act as vectors for the still doubtful virus of typhus. Moreover—but here, like Agag, I tread delicately,—may they not have something to do with that most mysterious of maladies, “P.U.O.A.”? *Pediculus vestimenti* is the more important.

I think it would only weary you

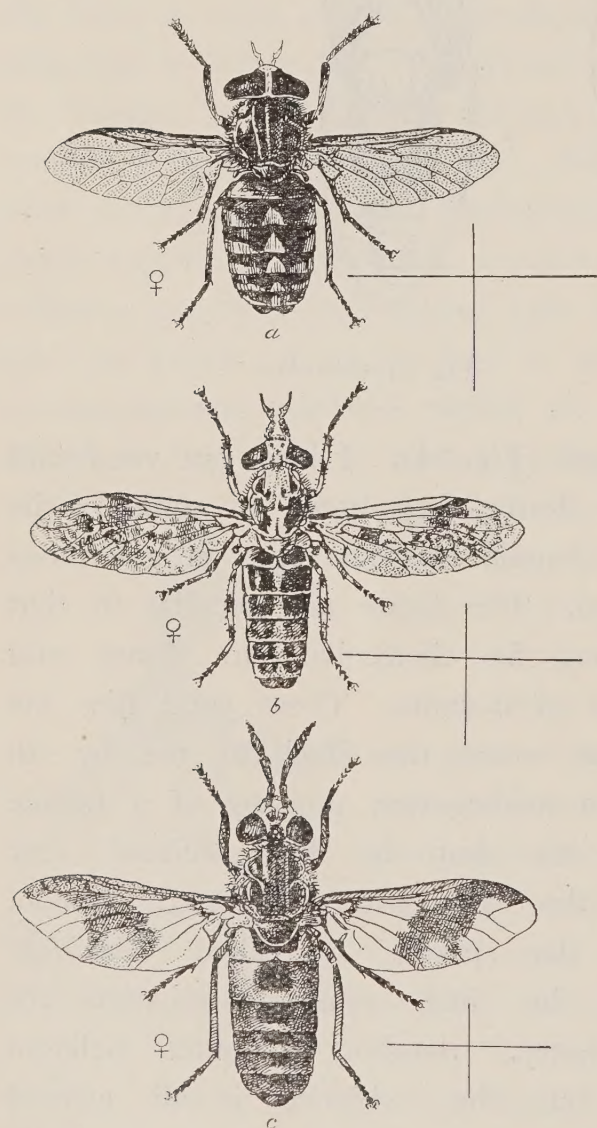


Fig. 25

a. Tabanid; b. Hæmatopota; c. Chrysops

if I entered into a dissertation upon lice, but there are one or two points which merit attention, and which have only recently come to light. Thus it has been proved that lice eggs are very hygroscopic

and that it does not require a very high temperature to kill them. Bacot has shown that lice, together with their eggs, can be destroyed in a moist temperature of 55°C . or 131°F . This is good hearing, for a recent work indicates that a female louse, during the six weeks of her eventful life, can actually produce 8000 young. Solomon advised the sluggard to consider the ant. Were he alive now, he might recommend the average British matron to study the female *P. vestimenti*.

I see that, following up the work of Nicolle on typhus fever, Dr. Jeanneret-Minkine has shown that the louse is only capable of transmitting the disease five days after it has fed from infected blood. It can then transmit infection for a period of two days. The virus is exalted in virulence by its sojourn in the louse. According to Nicolle, the fæces of lice are infective after nine or ten days, and he finds that

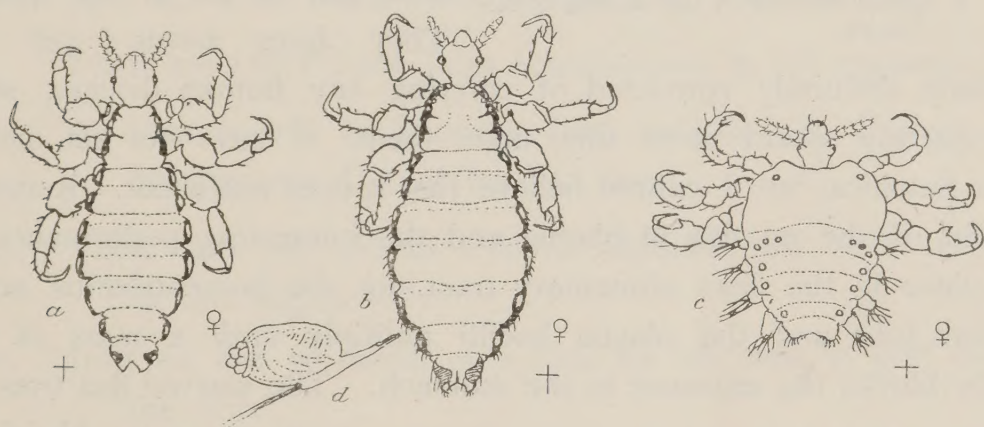


Fig. 26—The three species of Human Lice

a. *Pediculus capitis*; b. *Pediculus vestimenti*; c. *Pediculus (Phthirus) pubis*;
d. a louse egg attached to a hair

the infection is possibly hereditary. If relapsing fever ever occurs here upon a large scale, and I am glad to think that this is very unlikely, there will be a fine field for anyone who has time, to see if *Spirochæta recurrentis* behaves in the louse, like *S. berbera*, the spirochæte of North African relapsing fever. The disappearance of the spirochætes from the lice shortly after the latter feed, and their reappearance on the sixth day, is a most interesting and suggestive phenomenon, but its consideration would take us too far afield. Dr. Minkine devotes 60 pages of his book to lice and their destruction, so I think I had better not embark on the question of preventive measures. The few photographs exhibited will, I hope, be found of interest.

Gentlemen, the bed-bug is not absent from Salonica. The day I landed I called to pay my respects to the D.D.M.S. As I entered his office the thought flashed through my mind, "either they are killing vermin here or my old friend, Colonel Sutton, has a confirmed mastic drinker amongst his staff." I need hardly say that the former was the correct hypothesis. I do not know if anyone has studied the bed-bug here—

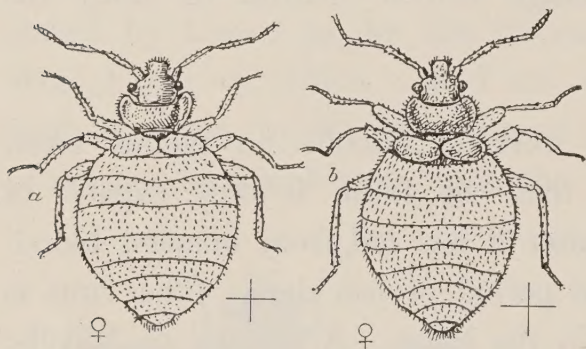


Fig. 27—*a. Cimex lectularius*, the common bed-bug of the temperate zone;
b. Cimex rotundatus, the bed-bug of the Tropics

probably the study has been the other way—but I expect both *Cimex rotundatus* and *C. lectularius*, the two main species, will be found to be present (Fig. 27). Wherever it can be used, the painter's lamp is the best thing for bed-bugs, provided always that fumigation with hydrocyanic acid gas is out of the question. They have never yet been

absolutely definitely convicted of carrying any human disease, so we need scarcely spend more time upon them. I have not yet met the flea in Salonica, but I cannot believe that it does not occur. Remember the rôle of the rat flea in plague and the interesting performance that takes place in the flea's alimentary tract, for the proventriculus acts as a culture tube and the plague bacilli multiply until a mass of them actually blocks the entrance to the stomach. The starved flea tries hard

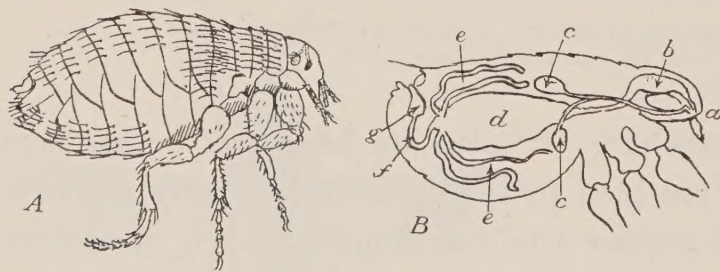


Fig. 28—A. The Human Flea, *Pulex irritans*; B. Internal anatomy of same

a. proboscis; b. sucking pharynx; c. salivary glands;
d. stomach; e. Malpighian tubules; f. intestine; g. rectum

to get more blood and its oesophageal contents regurgitate, infecting, through the skin lesion, the healthy person on whom the flea is trying to feed (Fig. 28).

Again, the flea in these parts very probably plays a rôle in what used to be called Potos, the form of Leishmaniasis or

Kala-Azar, found in Greece and its Archipelago. There is much that might be said about the flea, but all I can do is to imitate that lively insect and skip.

We thus come to the ants, which experimentally have been shown to be capable of transmitting *B. typhosus* and *V. cholerae* to food. Consider, therefore, the ways of the diligent, but predaceous ant, and take steps to keep it away from all forms of human nutriment.

Our next insect may be introduced to you through the medium of a story which, while undoubtedly a gross libel on a most worthy body of men, has the merit of indicating how widely the ravages of *Sarcoptes scabiei* may be spread (Fig. 29).

A visitor to the camp of a certain Highland regiment encountered the Sergeant-Major, and the following colloquy took place:—

Visitor: “Is there a Private Macpherson in this regiment?”

S.M.: “There are 217 Private Macphersons in this regiment.”

Visitor: “Ay! but it’s Private *John* Macpherson I am wanting.”

S.M.: “There are 125 Private John Macphersons in this regiment, Sirr.”

Visitor: “Ay! but ye will be knowing him because the Private John Macpherson I want has red hair.”

S.M.: “There are 52 Private John Macphersons with red hair in this regiment.”

Visitor: “Juist so, but ye canna miss him, for the man I want has got the itch.”

S.M.: “A’ the Macphersons hae the itch!”

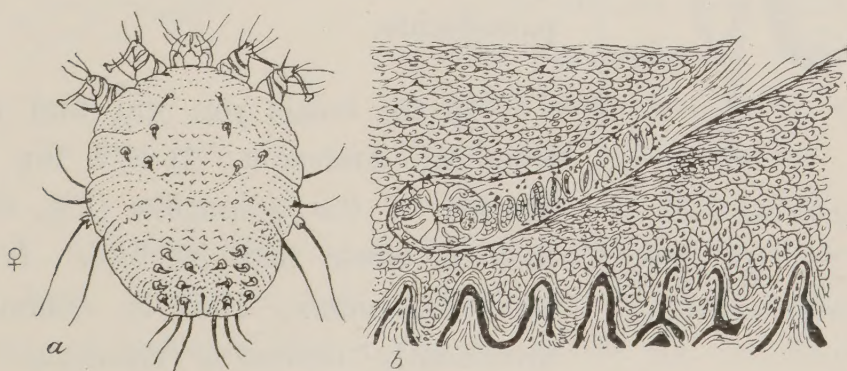


Fig. 29—*Sarcoptes scabiei*. The “Itch” Mite

a. female mite; b. female at the end of her burrow in the epidermis, with numerous eggs in various stages of development.

Well, Gentlemen, all the Salonican field force are, happily, not suffering in like manner, but I understand there is a good deal of this

troublesome skin infection. The cause is a mite, *S. scabiei*, and just as cheese mites tunnel into the best Stilton so does the female *Sarcoptes*, which is oval and yellowish-white, burrow down into the skin till she reaches the succulent Malpighian layer, leaving a row of eggs behind her as she bores her way inwards. Her work completed, she yields up the ghost at the end of her tunnel. The male is by no means so inquisitive and remains amongst the surface scales where, after mating, he also dies. The eggs vary from 22 to 50, and hatch after about seven days into hexapod larvæ. These moult twice on their passage to the surface, which they reach owing to the normal skin growth pushing them outwards. Pairing occurs while the female is still a nymph, and when the fertilised nymph has reached maturity she commences the burrowing business on her own account. The complete life-cycle lasts about 28 days. The infestation is more severe and widespread during hot weather. You are all familiar, indirectly I trust, with the symptoms of scabies, and you know that the itching is worst at night because it is then that the young females are chiefly on the move.

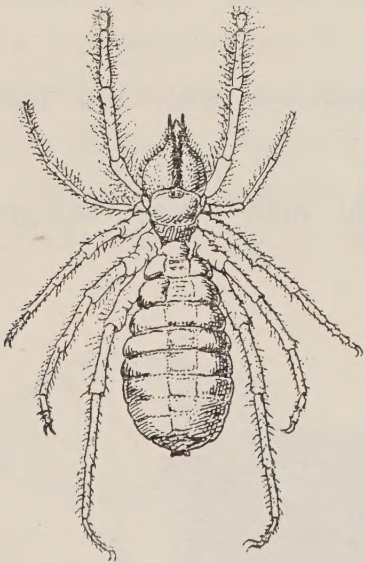


Fig. 30—A *Solpugid*,

An ugly-looking, though harmless, creature belonging to the same family as the spiders.

The free use of soap and warm water is indicated together with some parasiticide. For persons with delicate skins balsam of Peru is best, for the οὐ πᾶλλοι sulphur ointment is the thing, or baths of potassa sulphurata (1 ounce to 4 gallons of water). The patients' clothes should be stoved and a final bath taken to remove the parasiticide.

In the bottle you will find a present from Mr. Anderson. It is a fine specimen of one of the *Solpugidæ* (Fig. 30) whose look is worse than its bite. It is allied to the spiders, and is commonly but erroneously termed a tarantula. It does not secrete any poison but may inflict a rather painful wound. However, its shocking nakedness is its worst feature.

Gentlemen, you must think all insects are horrid, so I have kept to the end one that is far from being so, and that is the

diligent, ingenious and useful scavenger or Scarab Beetle. You will see him any day, hard at work, cleaning up the roads, gathering manure from the veldt-like stretches—a laborious and successful worker (Fig. 31).

In your fight against the insect pests of Salonica, which must of necessity be ceaseless, I would counsel you to take a lesson from the tireless Scarab. “Weary not in well doing,” must be your motto, and, if this is the case, you will assuredly not lose your reward—the reward of seeing the troops under your care healthy and comfortable, free from vermin, and not scourged, as they have been, by dire diseases; the reward of seeing military operations proceeding unhampered by countless sick; the reward of having helped your country in her time of need.

Gentlemen, I have only touched the fringe of a great subject, but I trust I have not wearied you. Still I cannot call a halt without expressing

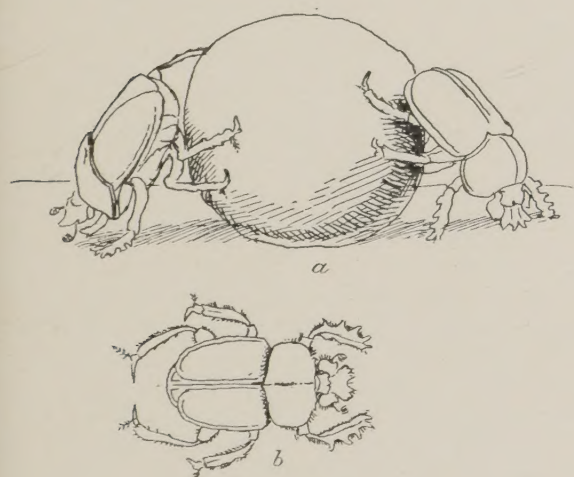


Fig. 31

- a. Scarab beetles rolling ball of dung ;
b. a Scarab beetle

my obligations to Colonel Roberts, Colonel Primrose, Captain MacKenzie, Captain Graham, Captain Armour, Captain Imrie and Mr. McTaggart of the 4th Canadian General Hospital, for much help and for the facilities they have afforded me; also to Mr. Anderson, already mentioned to the officers who are carrying out the anti-malarial work here and elsewhere; and lastly to the O.C. of this Hospital for his kind hospitality. I feel sure that they,

like myself, will feel more than repaid if this meeting has stimulated in those here present a real and abiding interest in the Medical Entomology of Salonica and in the preventive and remedial measures which form its natural corollary.

NOTE.—The illustrations in this reprint have kindly been arranged by Mr. M. E. MACGREGOR, Entomologist to the Wellcome Bureau of Scientific Research, and the drawings themselves executed by Mr. E. SCHWARZ, also of the Wellcome Bureau.

